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ABSTRACT

The Science in Action series is designed to teach practical science concepts to special-needs students. It is intended to develop students' problem-solving skills by teaching them to observe, record, analyze, conclude, and predict. This document contains a student workbook which deals with basic principles of physical science. Six separate units include: (1) making sounds; (2) high sounds and low sounds; (3) sound travels; (4) what sound travels through; (5) sound changes direction; and (6) using what you know. The units consist of basic introductory information and questions, worksheets, a self-checking quiz, and instructions for experiments. A cumulative test is provided at the end of the workbook, along with a glossary. The teachers guide (which is included) explains how to use the workbook, together with teaching suggestions and enrichment activities for each unit. (TW)

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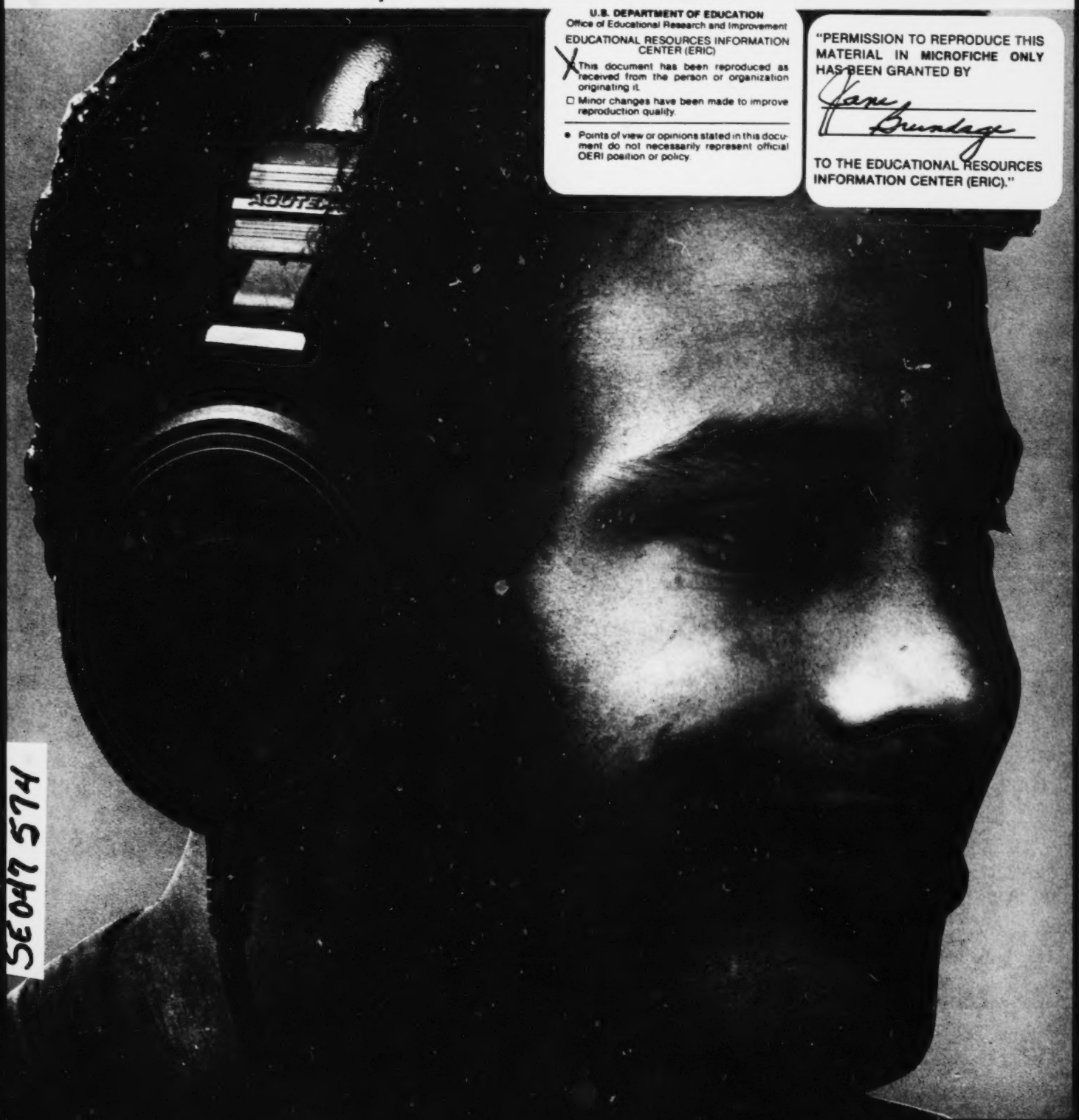
Sound

Physical Science in Action



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Sound

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Contents

Introduction 3
Unit 1 Making Sounds 4
Unit 2 High Sounds and Low Sounds 11
Unit 3 Sound Travels 19
Unit 4 What Sound Travels Through 25
Unit 5 Sound Changes Direction 33
Unit 6 Using What You Know 41
Show What You Learned 46
Glossary 47

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Teacher's Manual

Sound

Janis Fisher Chan

A Janus **Physical Science in Action** Book

Teacher's Manual written by Mary Friedland

OVERVIEW

Tuned-In to Science

Many special-needs students fear science. Yet these young people experience science in their every-day lives. We believe that those everyday experiences can be valuable learning tools.

So we wrote ***Sound*** to teach special-needs students more about a subject they're already familiar with in ways that are relevant to them. *Sound* addresses a teenager's interests. And it teaches useful science applications.

Sound is a Janus ***Science in Action*** workbook, written especially for the older adolescent who has difficulty reading, learning, and remembering. Through hands-on activities, *Sound* teaches what sound is, how sound is produced, and how it can be controlled.

We designed *Sound* to meet the needs of many special students. It teaches low-functioning students simple ways to control environmental sound. It introduces more capable students to common textbook experiments in sound.

Sound encourages all students to find out more. It presents enrichment activities at graduated levels of difficulty so that the needier students can succeed, and the more capable students can be challenged.

Success for the Slow Learner

Many slow learners have difficulty understanding abstract concepts. So, in *Sound,* we present concepts in a way that slow learners can understand.

Each lesson teaches one major concept. And every new concept builds on what the student has already learned. *Sound* uses reinforcement, review, and practical application to develop a student's skills and confidence.

Sound is part of the Janus ***Physical Science in Action*** workbook set. ***(Life Science in Action*** and ***Earth Science in Action*** sets are also available.) *Sound* can serve as either a core curriculum or a science supplement. It can be used to help your students meet general science or laboratory science graduation requirements.

OBJECTIVES OF THIS WORKBOOK

Science in Action workbooks are designed to help special-needs students learn practical science. The books build problem-solving skills, and help students learn to observe, record, analyze, conclude, and predict.

The objectives of the workbook are to help students:

- know what causes sound;
- understand why a sound is high- or low-pitched;
- be able to explain how sound travels;
- be able to demonstrate sound control techniques; and
- develop a basic vocabulary for discussing sound and sound control.

READABILITY

Sound is written below a 2.5 average reading level, according to the revised Spache Readability Formula. Target words (words important to understanding the science concepts) are highlighted in boldface type when they first appear in the text. Target words are also listed in a glossary at the back of the book, and in "Teaching the Units" in this manual.

We suggest that you work on target words each day. When you begin a unit, pronounce and define the words. Review the words as you're teaching the unit. Use the words in conversation, and encourage your students to do the same.

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HOW TO USE *SOUND*

The Format

The units in *Sound* are formatted to help students easily recognize what to do as they work through the book. Each unit begins with an introduction that prepares students for what they'll learn. The introduction poses topic questions and previews targeted science words.

A unit teaches one, two, or three core concepts. Lessons are short—one or two pages. Each lesson is followed by a reinforcement activity. Concepts are taught multimodally (by seeing, hearing, and doing) so all students can experience some success.

At the end of each unit, an exercise called "Check Yourself" tests core concepts and target words. "Check These Out" suggests enrichment projects at graduated levels of difficulty.

How to Introduce *Sound*

Play a tape of familiar sounds—some pleasant and some unpleasant. Ask students to identify the sounds and tell which ones they like.

Have students talk about how to control sound. For example, ask: *What do you do when you hear noise that bothers you? What if you're listening to music or watching TV and the sound bothers someone else?*

Then hand out the workbooks. As your students look through them, point out some of the experiments and activities they'll be doing. Read the introduction out loud. Ask students to name some sounds they'd like to be able to control.

How to Introduce a Unit

Start each unit with some kind of sound. You can use records, musical instruments, appliances, or anything else that relates to the learning in that unit.

Then have a student read the unit introduction. Ask students to guess the answers to the topic questions. Write down their answers and post them in the science area. As students work through the unit, they can compare those answers with what they learn.

Write "Before You Start" words on the chalkboard. Pronounce and define them. Have students look them up in the glossary. Give the students a reinforcement exercise (e.g., copying words and definitions, writing words in sentences) to do before the next class.

Some Teaching Suggestions

Keep the Class Together

Keep your students together so you can give them the guidance they'll need. Working with the class as a group enables you to give demonstrations, lead discussions, and present enrichment lessons.

Encourage interaction during class. Ask questions. Discuss the results of experiments and activities. Have students bring in news articles that relate to sound.

Help your students with unfamiliar activities. Walk them through an exercise the first time it appears. Then, when they repeat that exercise, allow them more independence.

Structure Activities and Experiments

Each experiment and activity demonstrates an important concept about sound. Help your students understand those concepts by structuring their activities. Have all materials ready when the class begins. Tell your students what they're going to do. (You may want to prepare a model of the activity.) Demonstrate procedures that might be confusing.

Be Prepared!

Preparation and organization are absolutely essential in teaching science. We suggest that you:

- Read through an entire unit before you teach it. Collect the materials you'll need.
- Try out all activities and experiments. Pretend you're a student. You may want to modify materials or procedures to fit your students' particular needs.
- Have extra materials on hand. Some students may damage or lose theirs.
- Research related topics. (The bibliography on page 6 of this manual suggests sources.) Keep reference books on hand in the science area.
- Have books and activities available for students who work quickly. (Suggested extended-learning projects appear under "Check These Out" in the workbook.)

The Mastery Test

The last unit of this book is a mastery test. "What's the Answer?" tests core concepts, and "What's the Word?" tests target vocabulary.

The Glossary

The glossary on page 47 of *Sound* lists target words that are boldfaced in the text. Entries are alphabetized and syllabified. Definitions include only what students need to know to understand the concepts in this book.

Encourage students to use the glossary to find out what target words mean and how to spell them. By using the glossary, students can also learn introductory dictionary skills.

TEACHING THE UNITS

Unit 1: Making Sounds

Target Words: *motion, vibration*

Unit 1 teaches that all sounds start with vibrations. Students listen to sounds and observe the vibrating objects producing those sounds.

The unit introduction asks students to listen for some common sounds. Help your students by playing a tape of the sounds suggested. Then ask students how they think those sounds are made.

On page 4, students encounter their first glossary exercise ("Before You Start"). You may want students to preview the glossary before doing this exercise.

PAGE 5: **Something Has to Move**

Students learn that vibration (a back-and-forth motion) causes sound. A guitar string, a fly's wings, a telephone, and a radio speaker all vibrate to produce sound.

Demonstrate what vibration is: Bring in a guitar. Have students pluck the strings and watch the vibrations.

PAGE 6: **Feel the Vibes**

Students feel vibrations in their throats as they hum. They feel vibrations in their teeth as they make a buzzing sound. Students conclude that vibrations and sounds start and stop simultaneously.

PAGE 7: **Sounds All Around**

Students are asked to find things they can *see* and *feel* vibrating. They list the things they find.

This exercise is best done outside the science room. You can assign it for homework, or take the class outdoors.

PAGES 8–9: **Experiment 1—What vibrates to make the sound?**

Materials: *thin ruler, 3 heavy books, soft drink bottle, table*

This is a two-part experiment. In each part, the student makes a sound and determines what vibrated to cause that sound.

Explain to your students that an experiment is *a controlled activity that answers a question.* Define *materials, procedures, observations,* and *conclusions.*

Observations: **1.** Each time you push the ruler down you hear a sound. **2.** Each time you blow across the bottle you hear a sound.

Conclusions: **1. b.** The ruler **2. c.** Air in the bottle

PAGE 10: **Check Yourself**

1. (Vibration is) **b.** back-and-forth motion. **2.** (Whenever you hear a sound,) **d.** something is vibrating. **3.** (When the vibration stops,) **a.** the sound stops. **4.** (You can see vibration) **e.** when you pluck a guitar string. **5.** (You can feel vibration in your throat) **c.** when you talk or sing.

Enrichment Activities

- Take the class to a musical performance. Ask students to identify as many musical instruments as they can.
- Show a film about sounds animals make to communicate.

Unit 2: High Sounds and Low Sounds

Target Words: *frequency, pitch*

This unit discusses pitch (how high or low a sound is). Students learn that the pitch of a sound is determined by its frequency (the speed of its vibrations).

The unit introduction explains that a woman's voice is *high* and a man's voice is *low.* Help your students understand what this means. Play records of male and female vocalists, or high- and low-pitched musical instruments (e.g., a flute and a tuba). Ask students to identify the high sounds and the low sounds.

PAGE 12: **Different Speeds**

Materials: *a rubber band*

Students learn that an object can vibrate at different speeds. The speed at which it vibrates is its *frequency.*

Students stretch a rubber band and pluck it. They notice that the tighter the rubber band is stretched, the faster it vibrates. They listen to the sound it makes. They conclude that fast vibrations produce high sounds and slow vibrations produce low sounds.

PAGE 13: **Hearing the Pitch**

Students learn that pitch is the highness or lowness of a sound. Students think of sounds that have high and low pitches. Then they produce some.

When students finish this exercise, discuss with them the sounds they thought of and produced.

PAGE 14: **Faster and Slower**

Students use a record player to find out the relationship between frequency and pitch. Before students begin, be sure they understand the function of the speed setting on the record player: When a record plays, a needle vibrates in the record's grooves. The speed the record is played at determines the frequency of the needle's vibrations. At the fastest speed (78), the needle vibrates fastest. At the slowest speed (33), the needle vibrates slowest.

PAGES 14–15: **Experiment 2—How can pitch be changed?**

Materials: *three-speed record player, 45 rpm record*

Students play a record at different speeds.

Observations: **1.** The pitch becomes higher when you change the speed from 45 to 78. **2.** The pitch becomes lower when you change the speed from 78 to 33.

Conclusions: **1.** Pitch can be changed by *changing* the *speed* of vibrations (the frequency). **2.** When vibrations become faster, the pitch becomes *higher.* **3.** When vibrations become slower, the pitch becomes *lower.*

PAGES 16–17: **Make a Musical Instrument**

Materials: *5 same-sized drinking glasses, a pitcher of water, a metal spoon*

Students make a five-pitch musical instrument by filling drinking glasses with water. They "play" the glasses by tapping them with a spoon. Then they line the glasses up according to pitch.

PAGE 17: **What's Happening?**

1. The glass with the most water has the *lowest* pitch.
2. The glass with the least water has the *highest* pitch.

PAGE 18: **Check Yourself**

Answers to puzzle: *Down* **1.** frequency **2.** vibrate **4.** pitch *Across* **3.** high **5.** musical

Enrichment Activities

- Show students how to make different musical instruments (e.g., water glasses, box guitar, comb and waxed paper). Make a tape recording of students playing their instruments either individually or as a "jugband."
- Invite a singer to visit your class. Ask the singer to describe different singing voices and to explain how a singer trains his or her voice.
- Show a film of vocal cords changing to produce high and low sounds.

Unit 3: Sound Travels

Target Words: *object, sound waves, surrounding*

Unit 3 describes sound waves. It explains how sound waves travel through air, and what happens when sound waves reach our ears.

The unit introduction states that sound travels. Illustrate this by positioning a few students in the corners of the room. Ask each student to make a sound while the class listens. Ask the class how they think those sounds got from the producer to the listener.

PAGE 20: **Traveling through Air**

Students learn how sound travels through air: A vibrating object causes vibrations in the surrounding air. Those vibrations set off vibrations in air farther away. As vibrations initiate more vibrations, sound travels outward from the object.

Pictures of a ringing alarm clock illustrate how sound travels. In the pictures, concentric arcs represent traveling sound. Tell your students that the arcs merely represent what happens.

Students are asked to list three sounds they hear traveling through the air. You may want to explain in greater detail what a vibrating object does to air. (See "Sound" in *The World Book Encyclopedia* for an explanation of how air molecules carry sound waves.)

PAGE 21: **Up, Down, and All Around**

Students learn that sound travels in *waves*. And sound waves move away *in all directions* from a vibrating object. Because of this, a radio can be heard from anywhere in the room it's in.

Students are asked to imagine what would happen if sound traveled only in a straight line. They conclude that in order to hear a radio, they'd have to be right in front of it.

PAGE 22: **How You Hear**

Students read a step-by-step description of how they hear the sound of a radio. Then those same steps are listed out of sequence, and students are asked to number the steps in the correct order.

PAGE 22: **What's the Order?**

1. A part in the radio vibrates and sets off sound waves. **2.** The sound waves travel through the air surrounding the radio. **3.** The sound waves enter your ears. **4.** Certain parts inside your ears vibrate, and you hear the sound.

PAGE 23: **Sounding Off**

Materials: *a record player, a record, a table*

In this activity, students play a record and listen to it from different parts of the room. They should hear the music from all six places. This happens because sound travels in all directions.

PAGE 24: **Check Yourself**

1. All sounds start from a vibrating *object*. **2.** Sound *waves* are vibrations in the air. **3.** A vibrating object sets off vibrations in the *surrounding* air. **4.** Sound waves spread out in all *directions*. **5.** Sound waves make certain parts inside your ears *vibrate*.

Enrichment Activities

- Do a unit on radio: Research the history of the radio; listen to old radio shows; find out and discuss how sound effects were made; produce and tape a student radio show; visit a radio station.
- Ask a person who works with the deaf to explain to your class how deaf people compensate.

Unit 4: What Sound Travels Through

Target Words: *gas, liquid, solid*

This unit teaches that sound travels through gases, solids, and liquids. The unit introduction describes how the sound of a siren travels through a closed car.

You can demonstrate how sound travels through something. Put an alarm clock in a drawer. Set it so it will ring during science class. When the alarm rings, ask your students what happens to the vibrations that started in the drawer.

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PAGE 26: **Traveling Sound**

Students learn that sound can travel through gases, solids, and liquids. You may want to review what gases, solids, and liquids are.

PAGE 27: **Sound through String**

Materials: *2 metal spoons, a string*

This activity is done in pairs.

PAGE 28: **Through Solids...**

Materials: *a long table, a door*

This two-part activity further demonstrates sound traveling through solids. Students work in pairs.

PAGE 29: **...And Liquids**

Materials: *a large glass bowl, water, two coins*

Students review their understanding of how sound travels by listing three solid things in the room that sound can travel through.

Then students work in pairs to demonstrate that sound travels through liquids.

PAGES 30–31: **Making a "String Telephone"**

Materials: *2 paper cups, long piece of string, 2 paper clips, a pencil*

Two students working together make a string telephone. They push a length of string through the bottoms of two paper cups, then fasten both ends of the string to paper clips. (Make sure they tie the string securely.) They pull the string taut. Using the paper cups, one student speaks while the other listens.

PAGE 31: **What's Happening?**

1. The string vibrated. The sound traveled through the string. **2.** The string won't vibrate unless it's pulled tight. **3.** If the string touches anything, the vibrations will stop.

PAGE 32: **Check Yourself**

1. Sound waves are set off when something *vibrates*. **2.** For you to hear, sound *waves* must travel to your ears. **3.** Every sound *travels* through something. **4.** Most *sounds* you hear travel through air. **5.** Air is a *gas*. **6.** Sound waves can travel through *solids*, such as metal or wood. **7.** Sound waves can also travel through liquids, such as *water*.

A	B	C	D	E	F	V	G	H	I	J	K
S	S	R	Q	P	O	I	N	S	O	S	I
O	T	U	V	W	Z	B	Y	Z	A	O	C
U	J	W	I	H	T	R	A	V	E	L	S
N	K	A	A	M	N	A	O	P	Q	I	S
D	C	T	A	V	Z	T	Y	O	X	D	V
S	D	E	F	G	E	E	H	G	A	S	K
W	V	R	T	S	R	S	Q	P	O	S	N

Enrichment Activities

- Show a film about Alexander Graham Bell and the invention of the telephone.
- Ask someone from a cable TV service to visit your class and explain how cable TV works.
- Have your class discuss noise pollution, its causes, and its prevention.

Unit 5: Sound Changes Direction

Target Words: *absorb, echo, reflect, surface*

Unit 5 discusses reflection and absorption of sound waves. When sound waves are reflected, the sound becomes louder. When sound waves are absorbed, the sound becomes quieter.

PAGE 34: **Sound Bounces**

Students learn that sound waves bounce off hard surfaces. Usually, reflected sound is heard along with the original sound, making the original sound louder. But sometimes the reflected sound is heard as an echo.

Students learned in unit 4 that sound waves travel *through* objects. Explain that not all sound waves hitting an object behave the same way. Some pass through the object, and some bounce back.

PAGE 35: **Sounding Louder**

Materials: *a cylindrical box*

Students show that reflection amplifies sound. By speaking into the air and then into a box, they discover that sound directed into the box is louder.

PAGE 35: **What's Happening?**

1. The sound is louder when you use the container. **2.** The sound is louder because the surfaces of the container reflect the sound. You hear the sound and the echo at the same time.

PAGE 36: **Sending and Collecting Sounds**

Students learn that they can direct sound waves. By cupping their hands around their mouths, they can direct the sound of their voices. By cupping their hands behind their ears, they can direct sound waves into their ears.

PAGE 37: **Making Sounds Quieter**

Students learn that soft surfaces absorb sound waves and make sounds quieter. Students are asked to list soft things that can absorb sound waves. (Rugs, pillows, etc.)

When you put rugs, pillows, and curtains in a room, the music sounds quieter. This is because the soft things absorb sound waves.

PAGES 38–39: **Experiment 3—What can keep a hard surface from reflecting sound waves?**

Materials: *an alarm clock, 2 cardboard boxes* (from a grocery store), *a lightweight blanket*

Experiment 3 demonstrates that soft surfaces absorb sound waves and make sounds quieter.

Students have an empty box and a box lined with a blanket. They move a ringing alarm clock from one box to the other.

Observations: **1.** The sound is *quieter* when you move the clock from the empty box to the lined box. **2.** The sound is *louder* when you move the clock back to the empty box.

Conclusion: **b.** Putting something soft on the hard surface.

Students conclude that putting something soft on a hard surface keeps that surface from reflecting sound waves. Ask them to suggest how this conclusion can be applied in their classroom and at home.

PAGE 40: **Check Yourself**

1. Hard surfaces *reflect* sound waves and make sounds louder. **2.** A sound that bounces back to your ears is called an *echo*. **3.** If you keep sound waves from *spreading*, a sound will be louder. **4.** Soft surfaces *absorb* sound waves and make sounds quieter. **5.** A sound is *louder* when you hear it and its echo at the same time. **6.** You can use soft things to make a sound *quieter*.

Enrichment Activities

- Bring in seashells for students to listen to. Have students make up stories about how the sound got in the shells.
- Take apart an old tube radio. Show students the speaker and tell them how it works. (Consult an old hobby book.)

Unit 6: Using What You Know

Target Words: *acoustical tile, acoustics, amplify, soundproof*

Students learn how to use acoustics to control sound. Then they apply their new knowledge to solve common problems in sound control.

PAGE 42: **Controlling Sound**

This lesson describes a problem in amplifying sound: A stereo is in the living room. Someone wants to hear its sound in the bedroom, but not bother the neighbors.

Before students are asked to solve this problem, they learn some ways that acoustical engineers control sound.

PAGE 43: **Making Sound Louder**

Students study a drawing of the living room and bedroom described on page 42. They suggest ways to direct the sound of the stereo to the bedroom.

PAGE 44: **Soundproofing**

This lesson describes a problem in soundproofing: Someone wants to watch TV in the bedroom without bothering people in the rest of the house.

Students read about common soundproofing techniques. Builders use rugs and carpets to soundproof floors. They use drapes and curtains to soundproof windows.

PAGE 45: **Making Sound Quieter**

Students study a drawing of the bedroom described on page 44. Hard surfaces are walls, ceiling, floor, furniture, etc. The hard surfaces amplify sound. To soundproof the room, students can add rugs, curtains, and pillows, move the TV so it doesn't face the door, etc.

Enrichment Activities

- Take the class to a recording studio. Have students find out about the acoustical engineering of the studio.
- Ask a stereo equipment salesperson to explain to your students what they should know about buying and using stereo equipment.

Show What You Learned

PAGE 46: **What's the Answer?**

1. b. A vibrating object **2. c.** Fast vibrations
3. a. In waves **4. b.** Travel through something
5. c. Reflects them

PAGE 46: **What's the Word?**

1. Vibration **2.** Frequency **3.** Pitch **4.** Reflect
5. Absorb **6.** Amplify **7.** Acoustics

TEACHING AIDS

Resources

- **Science museums**
- **Telephone companies** Most have a public relations department that distributes literature and films.
- **Musicians** and **music teachers**
- **Radio stations** They usually give tours.
- **Encyclopedias** contain good overviews and source guides. *The World Book Encyclopedia, Compton's Encyclopedia,* and the *New Book of Popular Science* are written at about a 6.0 reading level.

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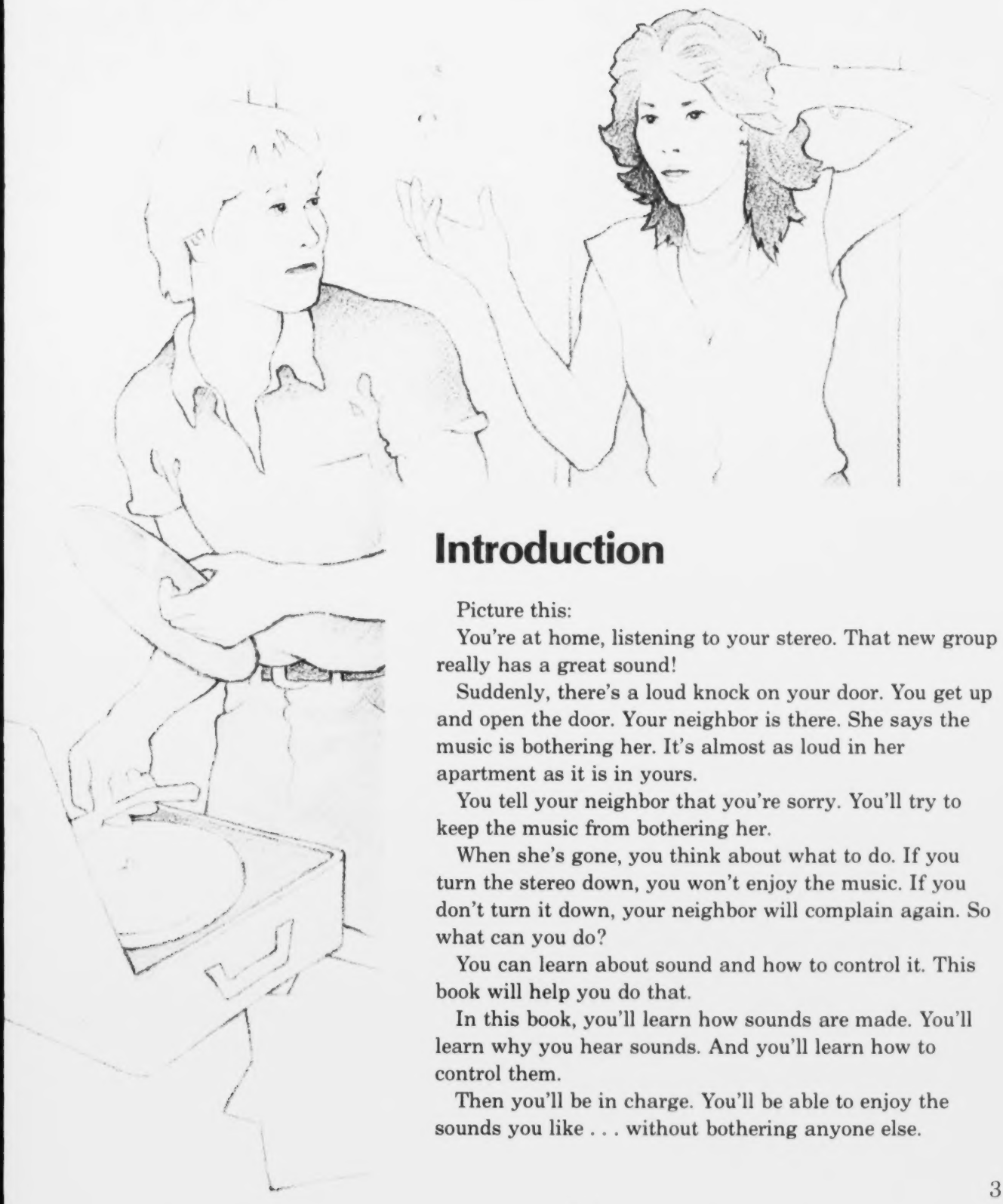


Introduction

Picture this:

You're at home, listening to your stereo. That new group really has a great sound!

Suddenly, there's a loud knock on your door. You get up and open the door. Your neighbor is there. She says the music is bothering her. It's almost as loud in her apartment as it is in yours.

You tell your neighbor that you're sorry. You'll try to keep the music from bothering her.

When she's gone, you think about what to do. If you turn the stereo down, you won't enjoy the music. If you don't turn it down, your neighbor will complain again. So what can you do?

You can learn about sound and how to control it. This book will help you do that.

In this book, you'll learn how sounds are made. You'll learn why you hear sounds. And you'll learn how to control them.

Then you'll be in charge. You'll be able to enjoy the sounds you like . . . without bothering anyone else.

Unit 1

Making Sounds

Listen. Do you hear people talking? Cars and trucks going down the street? A telephone ringing? Those are sounds you hear every day.

Sounds are all around you—many different sounds. The sound of your telephone ringing is different from the sound of your friend saying hello. But both of those sounds are made the same way.

- How are sounds made?

You'll learn the answer in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary that's at the back of this book. On the lines below, write what the words mean.

1. **motion** _____

_____

2. **vibration** _____

_____

Something Has to Move

Suppose you're playing a guitar. You pluck a string. (You pull it and let it go.) You see the string move back and forth. You hear a sound. What do you think makes the sound?

The back-and-forth motion of the string makes the sound. That motion is called vibration.

Every sound is made the same way—by vibration. You can't always see or feel the vibration. But if you hear a sound, something is vibrating.

A fly makes a buzzing sound by vibrating its wings. A telephone rings when something inside the telephone vibrates. How do you think a radio makes sounds?

Right. Something inside the radio vibrates. Put your hand on a radio when the radio is on. You'll feel the vibration.

A fly, a telephone, and a radio make different sounds. But to make any sound, something has to move. No matter what kind of sound you hear, it is made by one thing—vibration.

Feel the Vibes

When you talk or sing, something in your throat is vibrating. You can feel the vibrations in your throat. Here's how:

Put your fingers on the sides of your throat, just below your chin. Now hum. What do you feel?

Do you feel something vibrating? You should.

Put your fingers on the sides of your throat again. Hum again. Then stop. What happens when you stop humming?

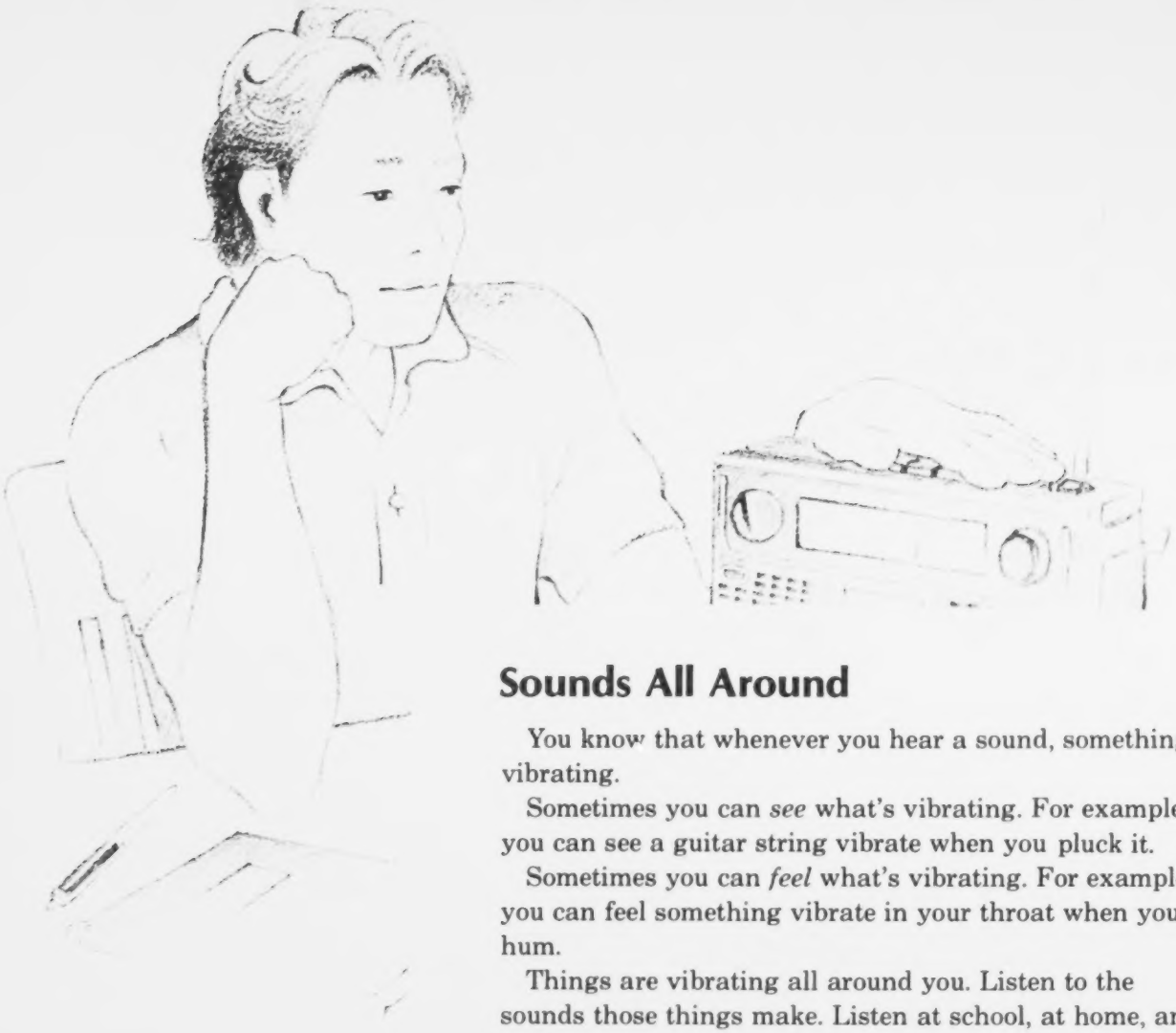
Do the vibrations stop? They should.

Here's another kind of vibration you can feel. Put your front teeth together and open your lips. Now make the sound *zzzzzzz*. What do you feel?

You should feel vibrations just behind your teeth.

What happens when you stop saying *zzzzzzz*?

Do the vibrations and the sound stop at the same time? They should.



Sounds All Around

You know that whenever you hear a sound, something is vibrating.

Sometimes you can *see* what's vibrating. For example, you can see a guitar string vibrate when you pluck it.

Sometimes you can *feel* what's vibrating. For example, you can feel something vibrate in your throat when you hum.

Things are vibrating all around you. Listen to the sounds those things make. Listen at school, at home, and on the street.

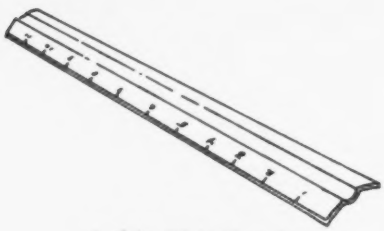
Find things that you can see vibrating. Find things that you can feel vibrating. On the lines below, list eight things you find.

Experiment 1
What vibrates to make the sound?

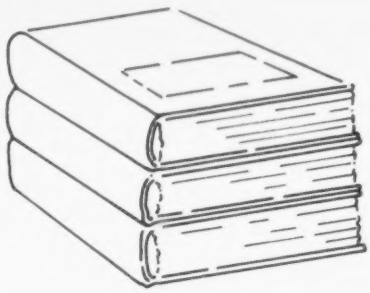
Sometimes when you hear a sound, it's easy to tell what's vibrating. Sometimes it's not so easy.

In this experiment, you'll make two different sounds. And you'll figure out what vibrates to make each sound.

Materials (What you need)



A thin 12-inch ruler

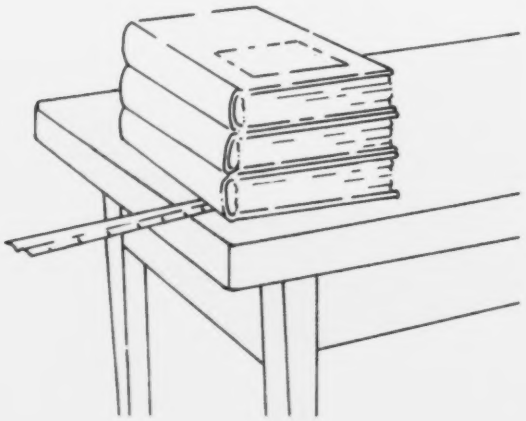


3 heavy books

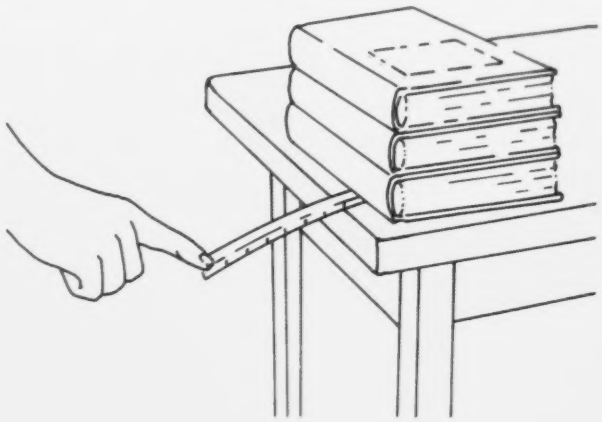
An empty soft-drink bottle

Procedure (What you do)

1. Make the first sound: Stack the books at the edge of a table. Place the ruler under the stack of books. Let about eight inches of the ruler stick out beyond the edge of the table.



2. Now push the end of the ruler down and quickly let it go. Do this two or three times. Listen each time.



3. Make the second sound: Get the bottle. Hold it so that the top of the bottle touches your bottom lip.

4. Now, with your lips almost closed, blow across the top of the bottle. Do this two or three times. Listen each time.

Observations (What you hear)

1. What happens each time you push the ruler down?

_____

_____

Do you hear a sound? You should.

2. What happens each time you blow across the bottle?

_____

_____

Do you hear a sound? You should.

Conclusions (What you learn)

Draw a line under the correct answer to each question.

1. What vibrates to make the first sound?
   a. The books
   b. The ruler
   c. Your hand

2. What vibrates to make the second sound?
   a. Your lips
   b. Something in your throat
   c. Air in the bottle

Check Yourself

Show what you learned in this unit. Finish these sentences. Draw a line from the words on the left to the correct words on the right.

1. Vibration is	a. the sound stops.
2. Whenever you hear a sound,	b. back-and-forth motion.
3. When the vibration stops,	c. when you talk or sing.
4. You can see vibration	d. something is vibrating.
5. You can feel vibration in your throat	e. when you pluck a guitar string.

Check These Out

1. Get these things: a sheet of paper; a bottle; a ruler; a rubber band; and some coins. Use them to make as many different sounds as you can.
2. Find some musical instruments at your school. Play them, or ask someone else to. Figure out what vibrates in each instrument.
3. As you work through this book, you may want to find out more about sound. You can find out more by looking in an encyclopedia or by getting books about sound from a library. You can also talk to an expert, such as a sound engineer, a musician, or a physics teacher.

   Here are some things you may want to find out:
   - What is a tuning fork? How does it work?
   - What are vocal cords? How do they make sounds?
   - Some insects vibrate parts of their bodies to make sounds. How does a cricket make sounds? How does a grasshopper make sounds?

Unit 2

High Sounds and Low Sounds

What's the difference between a woman's voice and a man's voice? Usually, a woman's voice is higher and a man's voice is lower.

You know that sounds, such as voices, are made by vibrations. But vibrations aren't all the same. So sounds aren't all the same either.

Some sounds are high, like the sound of the siren on a fire engine. Other sounds are low, like the sound of a dog growling.

- Why are some sounds high?
- Why are some sounds low?

You'll find out in this unit.

Before You Start

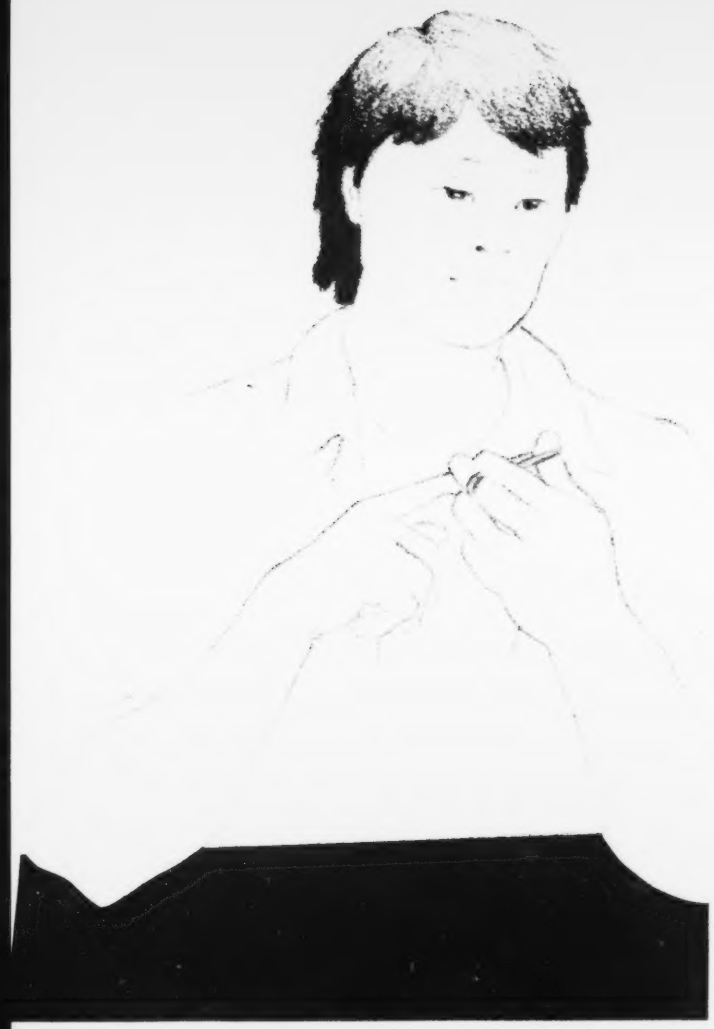
You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **frequency** _____

_____

2. **pitch** _____

_____



Different Speeds

Get a rubber band. Stretch it a little. Pluck it. Notice how fast it vibrates.

Now stretch the rubber band more. Pluck it again. Does it vibrate faster or slower than before?

It vibrates faster.

A thing can vibrate at different speeds. It can vibrate fast, or it can vibrate slow.

You learned that when a thing vibrates, it makes a sound. The sound can be high or low. That depends on how fast the vibrations are.

Get a rubber band again. Stretch it a little. Make it vibrate. Listen to the sound it makes. Then stretch the rubber band more. Make it vibrate faster. Listen to that sound. Is that sound higher or lower than the first sound?

That sound is higher. It's higher because the rubber band is vibrating faster.

You've seen that a thing can vibrate at different speeds. There's a name for the speed of vibration. The speed of vibration is called frequency.

If a thing vibrates fast, it has a high frequency. And it makes a high sound.

If a thing vibrates slow, what kind of frequency does it have?

What kind of sound does it make?

That's right. It has a low frequency, and it makes a low sound. You'll find out more about high and low sounds on the next page.

Hearing the Pitch

People use the word *pitch* to talk about sounds. The pitch of a sound is how high or low the sound is. A high sound has a high pitch. A low sound has a low pitch.

Here are three sounds that have a high pitch: a siren; a whistle; a bird singing.

Think of two more sounds that have a high pitch. Write them here.

_____

_____

Here are three sounds that have a low pitch: a dog growling; a tuba; a foghorn.

Think of two more sounds that have a low pitch. Write them here.

_____

_____

Now make some sounds. Use your voice or things in the room. Write how you make each sound. Then write if it has a high pitch or a low pitch.

Sound:	**Pitch:**
_____	_____
_____	_____
_____	_____

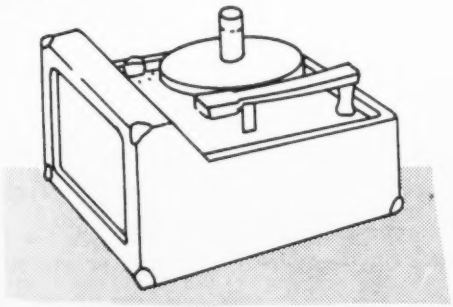
Faster and Slower

When you play a record, the record spins on a turntable. A needle touches the spinning record and vibrates. The vibrations of the needle make the sound that you hear.

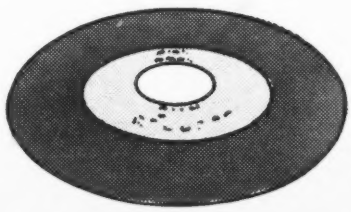
Can you change the pitch of that sound? Do this experiment and find out.

Experiment 2
How can pitch be changed?

Materials



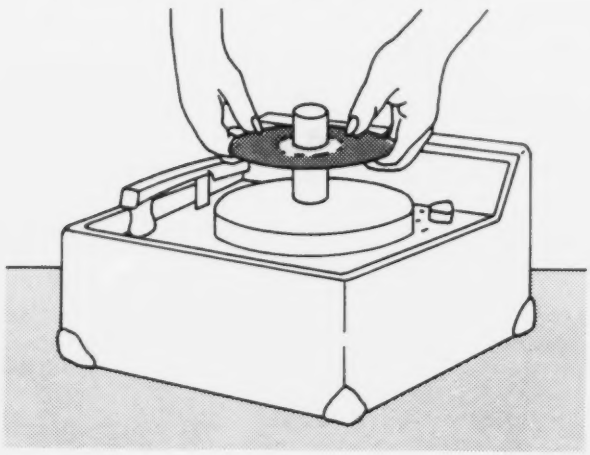
A three-speed record player



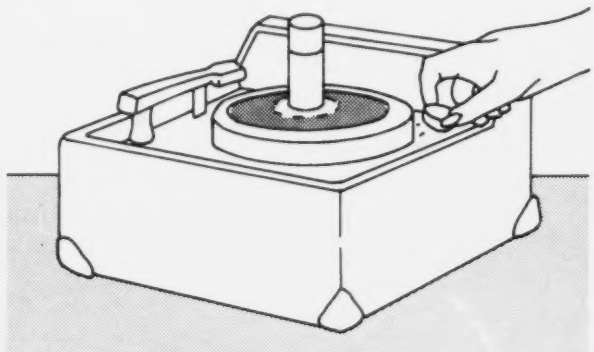
A "45" record
of someone singing

Procedure

1. Get the record player. Put the record on the turntable. Turn the record player on.



2. Set the speed at 45. Play part of the record and listen.



3. Set the speed at 78. Play the record and listen. Pay attention to the pitch.

4. Set the speed at 33. Play the record. Pay attention to the pitch.

Observations

1. When you change the speed from 45 to 78, the needle vibrates faster. The pitch changes. Does it become higher or lower?

   _____

2. When you change the speed from 78 to 33, the needle vibrates slower. The pitch changes. Does it become higher or lower?

   _____

Conclusions

How can pitch be changed? Finish the sentences below. Write these words where they belong.

higher	lower
speed	changing

1. Pitch can be changed by _____

   the _____ of vibrations (the frequency).

2. When vibrations become faster, the pitch becomes

   _____ .

3. When vibrations become slower, the pitch becomes

   _____ .

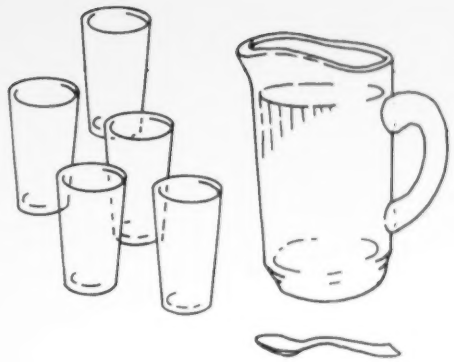
Make a Musical Instrument

A musical instrument makes sounds of different pitches. Think about a guitar. Each string on a guitar has a different pitch.

You can make a musical instrument that has five different pitches. You'll need:

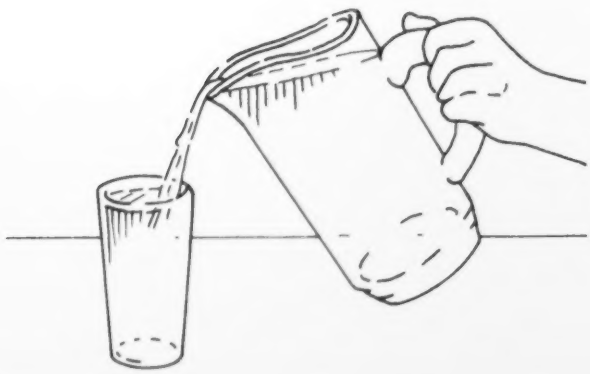
- 5 glasses, all the same size
- A large pitcher of water
- A metal spoon

Here's what to do:



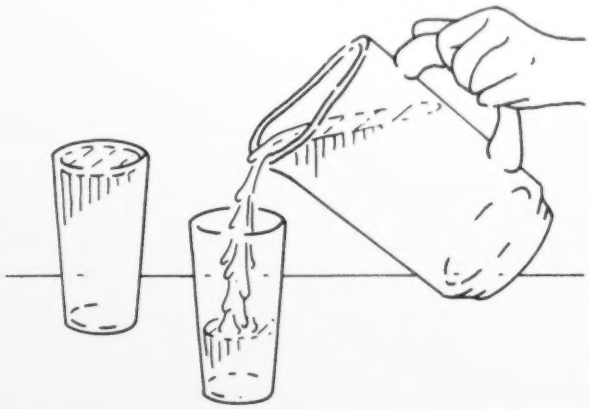
1

Fill one glass to the top with water.



2

Pour water into another glass. Make it a little less full than the first glass.

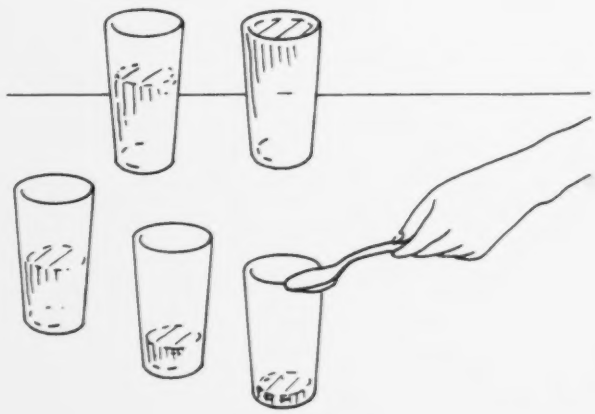


3

Pour water into the other three glasses. Pour a different amount into each glass.

4

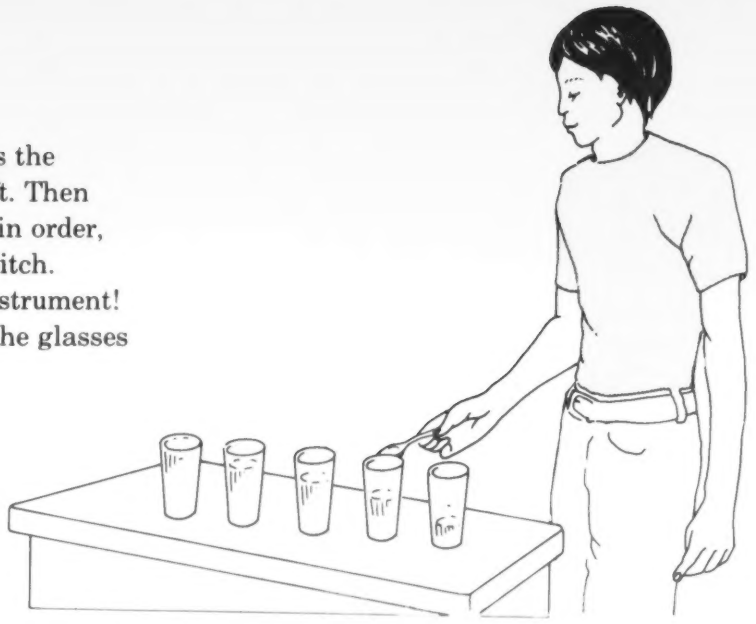
Tap the glasses with the spoon. Listen as you tap each glass. You should hear five different pitches.



5

Pick up the glass that has the lowest pitch. Put it at your left. Then line up the other four glasses in order, from lowest pitch to highest pitch.

You've made a musical instrument! Play a tune on it by tapping the glasses with the spoon.



What's Happening?

Finish these sentences. Write *highest* or *lowest*.

1. The glass with the most water has the _____ pitch.
2. The glass with the least water has the _____ pitch.

Check Yourself

Use words from this unit to do the crossword puzzle. The words you'll need are listed below.

The first one is done for you.

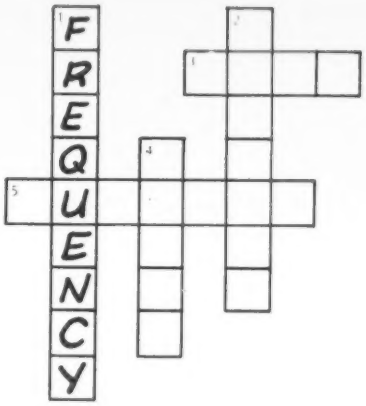
vibrate	frequency	musical
high	pitch	

Down

1. Speed of vibration
2. Move back and forth
4. How high or low a sound is

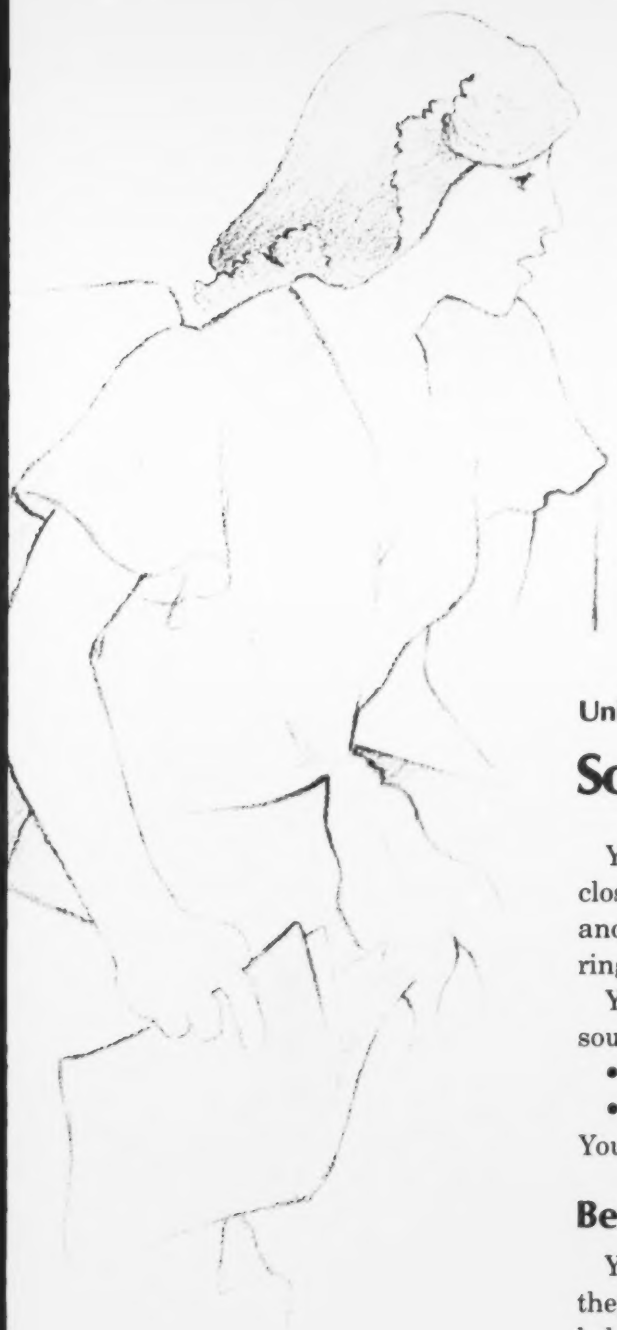
Across

3. The pitch of a ringing telephone
5. An instrument like a guitar



Check These Out

1. Look inside a piano. Notice the strings. Some strings are longer than others. When the piano is played, the strings vibrate. Which strings make low sounds? Which strings make high sounds?
2. Find pictures of musical instruments in magazines and newspapers. Cut out the pictures. Put them in three groups: instruments you pluck; instruments you blow into; and instruments you hit. For each instrument, figure out what vibrates.
3. Make a "box guitar." Get an empty tissue box with a large opening. Get a few rubber bands—some thick ones and some thin ones. Put the rubber bands around the box the long way. Play the guitar by plucking the rubber bands over the opening.
4. Here are some things you may want to find out:
   - What is ultrasonic sound? How do doctors use it? How does the U.S. Navy use it?
   - Why does each string on a guitar have a different pitch?
   - Some animals can hear sounds that are too high or low for people to hear. Which animals can do that?



Unit 3

Sound Travels

You can easily hear the telephone ring when you are close to it. But you can also hear it ring when you are in another room. You may even be able to hear the phone ring when you are outside the house.

You can hear the phone from all those places because sound travels.

- How does sound travel?
- How do you hear sound?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **object** _____

_____

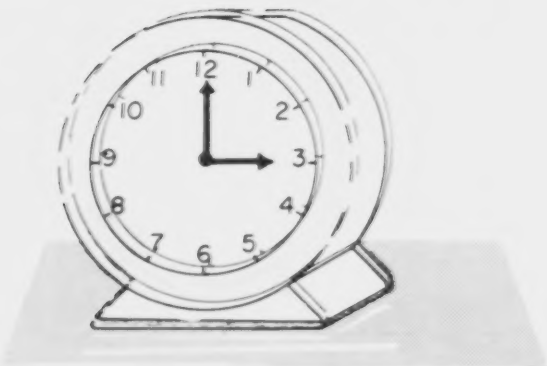
2. **surrounding** _____

_____

Traveling through Air

Think of an alarm clock going off. You know that the sound of the alarm starts with vibrations. For you to hear that sound, the vibrations have to travel. They have to travel from the clock to your ears.

What do you think the sound travels through?



_____

The sound travels through air. It travels through the air that's between the clock and your ears.

How does sound travel through air? This is what happens:

An object vibrates, or moves back and forth. That vibration makes the air right next to the object vibrate. (Look at picture **A**.)

That vibrating air makes air farther from the object vibrate. (Look at picture **B**.)

What happens then? (Look at picture **C**.)

_____

Air farther and farther from the object vibrates.

So, a vibrating object sets off vibrations in the surrounding air. Those vibrations travel through the air to your ears. And that's when you hear the sound.

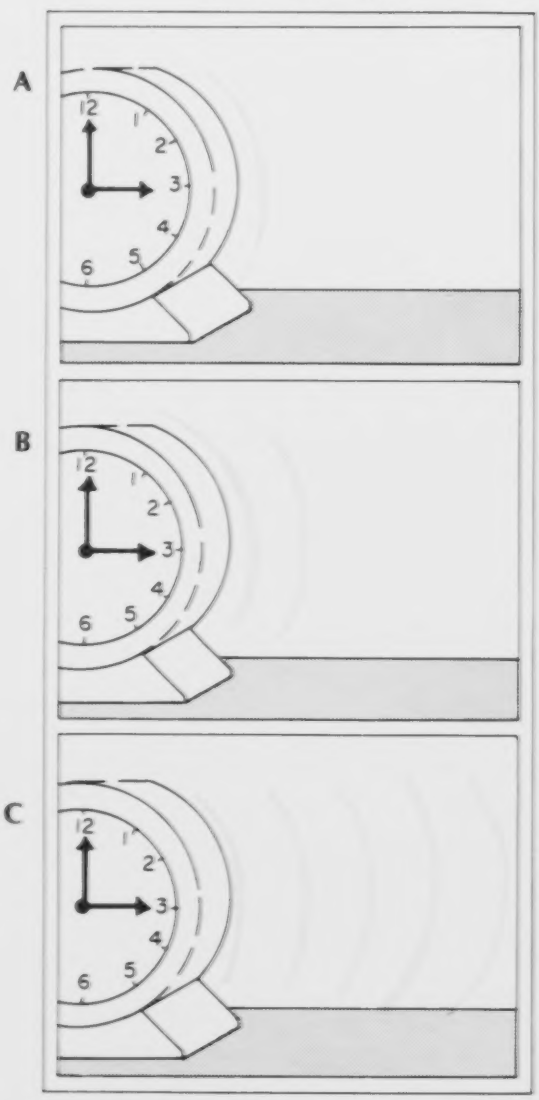
Listen for a minute. List three sounds that are traveling through the air right now.

_____

_____

_____

How sound travels



Up, Down, and All Around

Suppose you're lying in bed, listening to the radio. You're right in front of the radio. If you get up and move away from the radio, where else in the room can you hear it from?

_____

You can hear the radio from anywhere in the room.

You learned that a vibrating object sets off vibrations in the surrounding air. Those vibrations are called **sound waves**.

Sound waves move away from the vibrating object. They spread out in all directions. They travel up, down, and all around.

That's why you can hear the radio from anywhere in the room. You can hear it when it's in front of you or behind you. And you can also hear it when it's above or below you.

Suppose sound didn't travel in all directions. Suppose it traveled only in a straight line. Could you still hear the radio from anywhere in the room?

_____

No, you couldn't. Where would you have to be to hear the radio?

_____

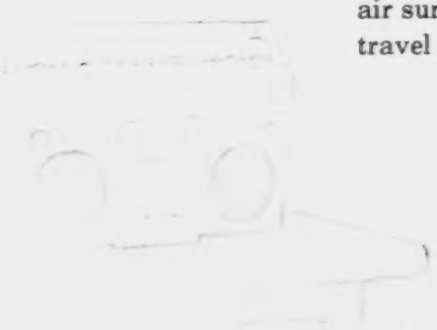
_____

How You Hear

How do you hear the sound of a radio? The picture on this page shows you how. Read the steps.

1. A special part in the radio vibrates. That vibration sets off sound waves.

2. The sound waves travel through the air surrounding the radio. They travel farther and farther.



3. The sound waves enter your ears.

4. When the waves reach certain parts inside your ears, those parts vibrate. And that's when you hear the sound.

What's the Order?

The steps below tell how you hear the sound of a radio. But the steps are out of order. Put them in order. Write *1*, *2*, *3*, or *4* in front of each step.

_____The sound waves travel through the air surrounding the radio.

_____The sound waves enter your ears.

_____A part in the radio vibrates and sets off sound waves.

_____Certain parts inside your ears vibrate, and you hear the sound.

Sounding Off

You can see for yourself that sound waves travel in all directions. Here's how:

Get a record player. Put it on a table in the middle of the room. Play a record. Now go to each place listed below. Can you hear the music from that place? Put an **X** in the box that shows your answer.

	Can hear	Can't hear
1. The front of the room	☐	☐
2. The back of the room	☐	☐
3. Close to the floor	☐	☐
4. Up on a chair	☐	☐
5. By the door	☐	☐
6. Next to a window	☐	☐

You listened from six different places. From how many of those places could you hear the music?

_____

You probably could hear the music from all six places. Why?

_____

Check Yourself

Show what you learned in this unit. Finish these sentences. Use the words listed below. One word will be left over.

waves	directions	object
alarm	surrounding	vibrate

1. All sounds start from a vibrating _____.
2. Sound _____ are vibrations in the air.
3. A vibrating object sets off vibrations in the _____ air.
4. Sound waves spread out in all _____.
5. Sound waves make certain parts inside your ears _____.

Check These Out

1. Find out more about how people hear. Ask a doctor who takes care of hearing problems to visit your class. Before the doctor visits, write down some questions to ask him or her.
2. Some people who can't hear use sign language to "talk" to other people. Find out about sign language. Learn how to "sign" your name.
3. Some deaf people can dance to music. Find out how they "hear" the music.
4. Here are more things you may want to find out:
   - How does a hearing aid work?
   - What is an oscilloscope? What is it used for?
   - What is the Doppler effect? What causes it?
   - What are molecules? What happens to molecules when sound travels?
   - What happens to sounds outdoors on a windy day?

Unit 4

What Sound Travels Through

Suppose you're driving along in your car. All the windows are closed. Suddenly you hear the siren of a fire truck. You hear it clearly even though the windows are closed. Why? Because sound travels. It travels through different kinds of things.

• What kinds of things can sound travel through? You'll find out in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **gas** _____

_____

2. **liquid** _____

_____

3. **solid** _____

_____

Traveling Sounds

The bell inside a telephone vibrates and sets off sound waves. For you to hear the sound, those sound waves must travel. They must travel from the vibrating bell to your ears. And they must travel through something. What do the sound waves travel through?

Right. The sound waves travel through air.

Most sounds that you hear travel through air. That's because your ears are usually surrounded by air. And so are most of the objects that make sounds.

But sounds travel through other things besides air, which is a gas. They travel through solids, such as wood or metal. They also travel through liquids, such as water.

Because sound travels through many kinds of things, you can hear sounds from far away. You can even hear sounds through walls.

Imagine you are outdoors. You hear a jet plane flying high over your head. What do you think the sound travels through to reach your ears?

The sound travels through air.

Suppose you are in a closed room. You hear the sound of a TV from another room. What does the sound travel through to reach your ears?

The sound travels through air. It also travels through the walls of the room.

Every sound you hear travels through something. Otherwise, you would not be able to hear it.

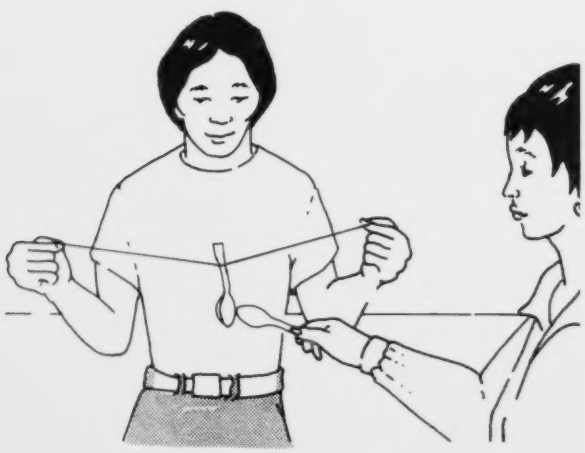
Sound through String

You know that sound travels through air. Air is a gas.

Can sound also travel through a solid? You and a partner can find out. First, get two metal spoons and a piece of string about three feet long. Then do this:

1

Tie one spoon to the middle of the string. Hold the ends of the string so that the spoon hangs down.



2

Have your partner tap the hanging spoon with the other spoon. Listen. You'll hear a sound. What does that sound travel through?

_____

That sound travels through air, which is a gas.

3

Now put the ends of the string in your ears. Have your partner tap the hanging spoon again. Listen again. You'll hear another sound. What does that sound travel through?

_____

That sound travels through the string. The string is made of a solid. On the next page, you'll learn about some other solids that sound can travel through.

Through Solids . . .

You learned that sound can travel through a string. Can sound also travel through other solids? Find out for yourself. Here's how:

Get a partner. Stand at one end of a table. Ask your partner to stand at the other end. Have your partner tap the table. You'll hear a sound that travels through air.

Now put your ear against the edge of the table. Cover your other ear with your hand. Have your partner tap the table again. Do you hear a sound?

What does the sound travel through?

The sound travels through the table. The table is made of a solid. What solid is the table made of?

The table is probably made of wood. But it may be made of metal or plastic.

Next, do this: Go outside the room. Leave the door open. Ask your partner to stay inside the room and call your name. You'll hear your partner's voice. It travels through air.

Now close the door. Put your ear against the door. Have your partner call your name again. Do you hear your partner's voice?

What does the voice travel through?

Your partner's voice travels through the door. The door is made of a solid. What solid is the door made of?

The door is probably made of wood.

. . . And Liquids

You found out that sound can travel through a table or a door. Look around you. Find three more things that sound can travel through. Find things made of solids such as wood, metal, plastic, or glass. On the lines below, list the three things and what they're made of.

Thing: _____

Solid it's made of: _____

_____

Thing: _____

Solid it's made of: _____

_____

Thing: _____

Solid it's made of: _____

_____

You learned that sound travels through gases and solids. What else can sound travel through?

_____

Yes, sound can travel through liquids.

To make sure of this, work with your partner again. Get two coins and a big glass bowl of water.

Have your partner tap the two coins together. You'll hear a sound that travels through air.

Now put your ear against the bowl. Have your partner hold the coins under the water and tap them together again. You'll hear a sound. What does the sound travel through?

_____

The sound travels through the water (and, of course, the bowl). Water is a liquid.

Making a "String Telephone"

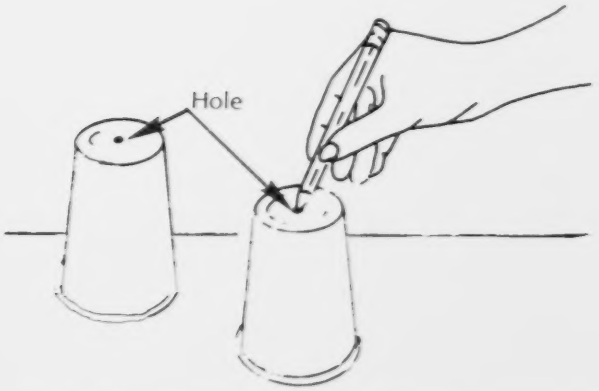
You can make a "string telephone." To do it, you'll need:

- 2 paper cups
- A piece of string about eight feet long
- 2 paper clips
- A pencil

Get a partner and do this:

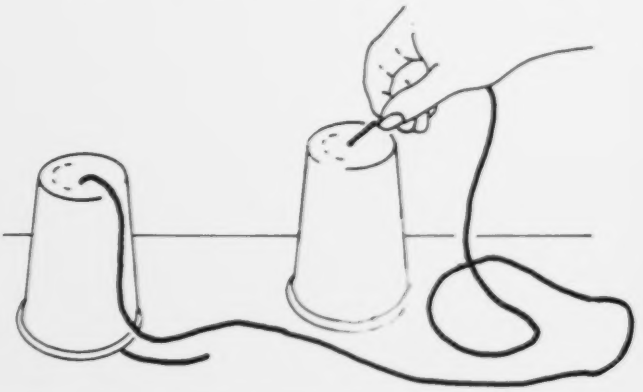
1

With the pencil, poke a small hole in the bottom of each cup.



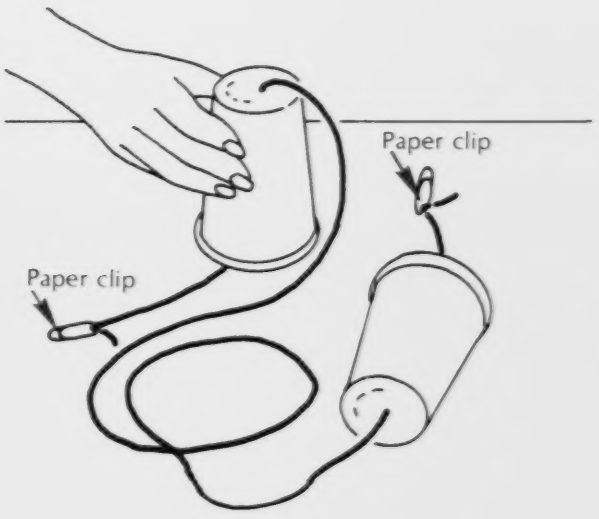
2

From the outside of each cup, push one end of the string through the hole. Push about six inches of string through.



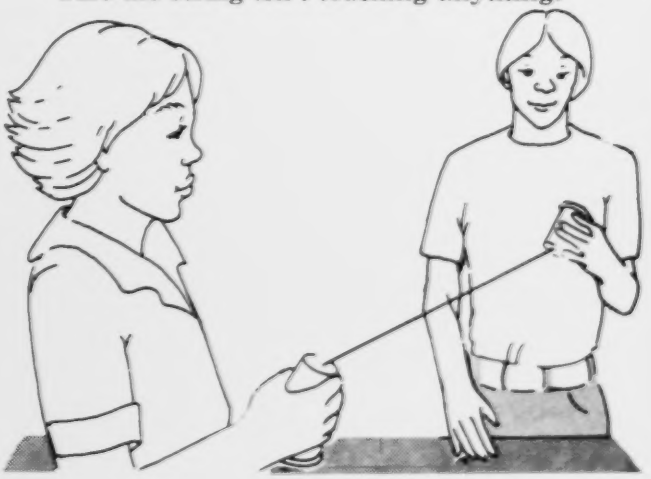
3

Tie each end of the string to a paper clip. (The clips will hold the string in place.)



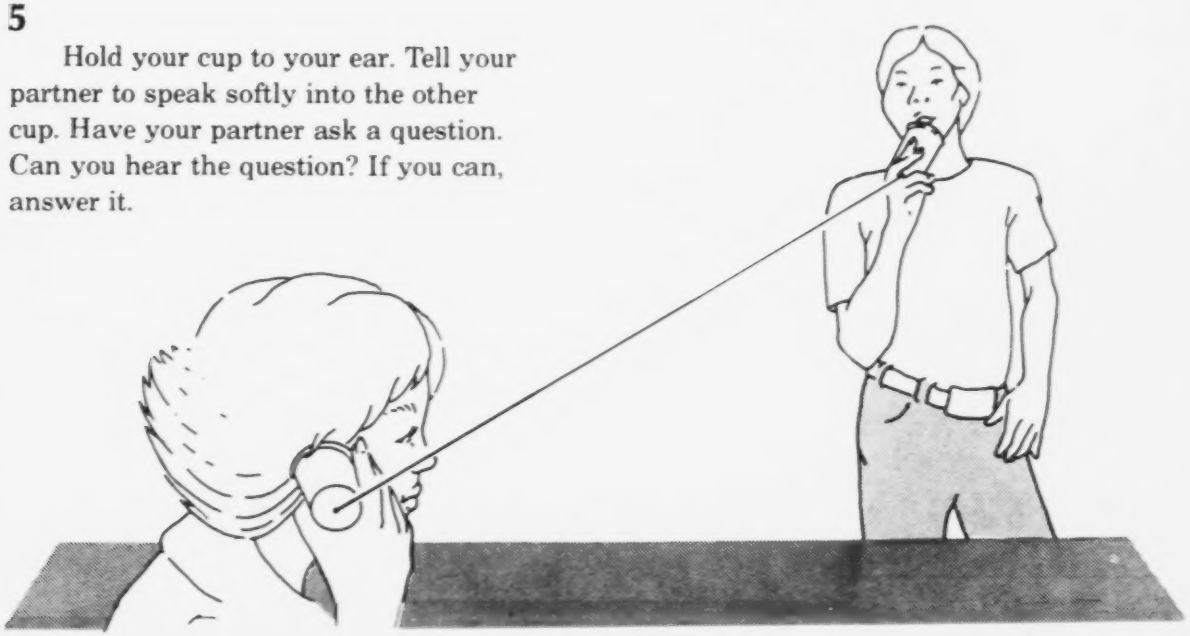
4

Give one cup to your partner. Keep the other cup. Move away from your partner until the string is tight. Be sure the string isn't touching anything.



5

Hold your cup to your ear. Tell your partner to speak softly into the other cup. Have your partner ask a question. Can you hear the question? If you can, answer it.



What's Happening?

1. Your partner spoke softly into the cup. But you could hear your partner's voice. Why?

_____

_____

You could hear your partner's voice because the sound made the string vibrate. The sound traveled through the string.

2. Your string telephone won't work unless the string is pulled tight. Why?

_____

_____

The string won't vibrate unless it's pulled tight.

3. Your string telephone won't work if the string touches anything. Why?

_____

_____

If the string touches anything, the vibrations will stop.

Check Yourself

Seven words from this unit are missing from these sentences. Write those words in the sentences.

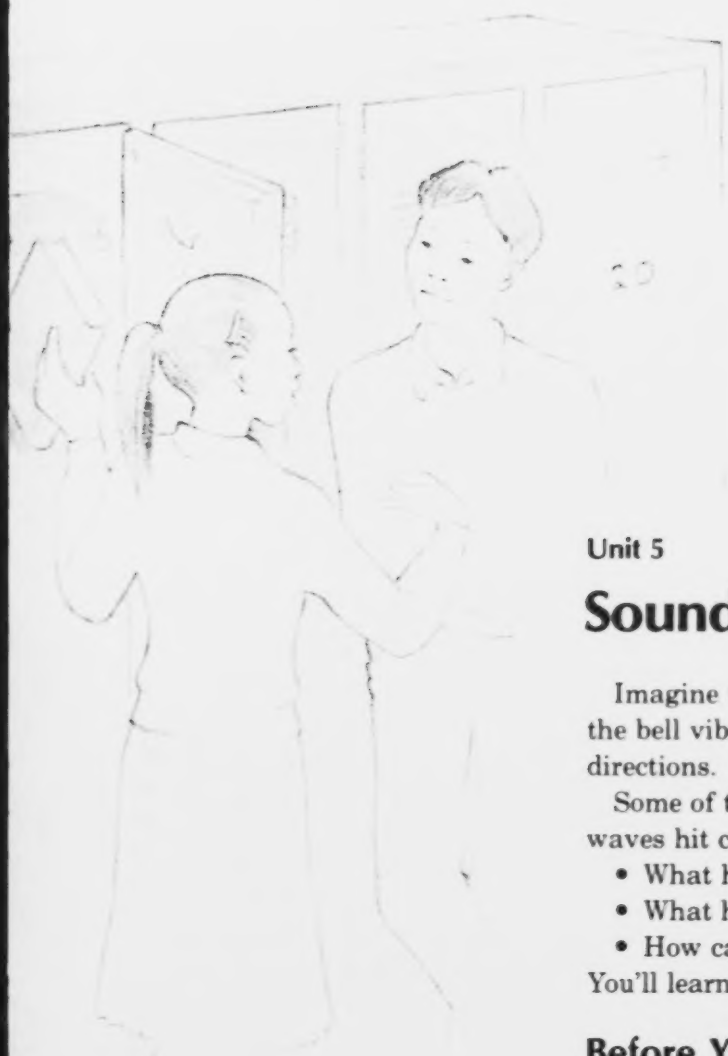
Then find those words in the puzzle and circle them. The words are printed across, down, and on a slant.

1. Sound waves are set off when something v _ _ _ _ _ _ _ .
2. For you to hear, sound w _ _ _ _ must travel to your ears.
3. Every sound t _ _ _ _ _ _ through something.
4. Most s _ _ _ _ _ you hear travel through air.
5. Air is a g _ _ .
6. Sound waves can travel through s _ _ _ _ _ , such as metal or wood.
7. Sound waves can also travel through liquids, such as w _ _ _ _ .

A	B	C	D	E	F	V	G	H	I	J	K
S	S	R	Q	P	O	I	N	S	O	S	I
O	T	U	V	W	Z	B	Y	Z	A	O	C
U	J	W	I	H	T	R	A	V	E	L	S
N	K	A	A	M	N	A	O	P	Q	I	S
D	C	T	A	V	Z	T	Y	O	X	D	V
S	D	E	F	G	E	E	H	G	A	S	K
W	V	R	T	S	R	S	Q	P	O	S	N

Check These Out

1. Find out how a telephone works. Ask someone from the telephone company to explain it to your class.
2. Sounds travel faster through the ground than they do through the air. Hunters know that. So they sometimes put an ear to the ground to listen for animals. What are other ways that people listen to sounds through solids? Draw a picture that shows one of those ways.
3. Here are more things you may want to find out:
   - What is the sound barrier? What happens if an airplane goes faster than the speed of sound?
   - Why do you hear thunder after you see the lightning that causes it?
   - Whales and porpoises can send sounds that travel 100 miles. How do they do that?



Unit 5

Sound Changes Direction

Imagine this: A school bell rings. The air surrounding the bell vibrates. And sound waves travel out in all directions.

Some of the sound waves hit walls. And some of the waves hit curtains. Something happens to those waves.

- What happens when sound waves hit hard objects?
- What happens when sound waves hit soft objects?
- How can you make sounds louder or quieter?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **absorb** _____

_____

2. **reflect** _____

_____

3. **surface** _____

_____

Sound Bounces

Sound waves travel away from a vibrating object. They keep traveling away from the object unless they hit a hard surface. What do you think will happen when the sound waves hit a hard surface?

The sound waves will bounce. The hard surface will reflect most of the sound waves.

Picture this: You're playing drums in an empty room. You hit a drum. Some sound waves travel toward the wall. What happens when they hit the wall?

The wall reflects the sound waves. The sound waves bounce off the wall.

Suppose the sound waves bounce all the way across the room. They hit another wall. What happens then?

Right. That wall reflects the sound waves again.

The sound waves may bounce several times. Finally, they will slow down and stop.

Sound waves bounce off hard surfaces. So you sometimes hear the same sound more than once. You hear the sound when it first happens. Then you hear it again when a hard surface reflects the sound waves back to your ears.

What do you call a sound that bounces back to your ears?

You call that sound an **echo**.

You might hear echoes in a large cave. Why?

The walls of the cave reflect the sound waves.

Sounding Louder

Suppose you shout. A hard surface reflects the sound. You might hear an echo.

But if you're too close to the hard surface, you won't hear the echo. The echo will reach your ears very quickly. You will hear the sound and the echo at the same time. The echo will make the sound louder.

Try making a sound louder. You'll need an empty container. It should be tall and round, like an oatmeal box.

1

Say *ha, ha, ha*. Listen to the sound.

2

Hold the container up to your mouth. Say *ha, ha, ha* into the container. Listen to the sound.

What's Happening?

1. How is the sound different when you use the container?

Is the sound louder? It should be.

2. Why is the sound louder?

The surfaces of the container reflect the sound. You hear the sound and the echo at the same time.

Sending and Collecting Sounds

Suppose your friend is standing across the street. You shout, but your friend can't hear you. Then you cup your hands around your mouth and shout again. What happens?

Right. Your friend hears you. Your hands keep the sound waves from spreading out. That way, you send all the sound waves in one direction — toward your friend.

You can send sound waves in any direction. But you need something like your cupped hands to keep the waves from spreading out.

Now suppose your friend shouts back to you. You can't hear him.

So you cup your hands behind your ears. What happens?

You can hear your friend. Your hands collect the sound waves.

Even without your hands, your ears are shaped to collect sound waves. But with your hands behind them, your ears collect more sound waves.

Try it. Cup your hands behind your ears. Slowly turn your head from side to side. Listen. You should hear more. Why?

Your hands help your ears collect sound waves.

Making Sounds Quieter

You've learned that a hard surface, such as a wall, reflects sound waves. It makes sounds louder. But a soft surface, such as a curtain, doesn't reflect sound waves very well.

A soft surface has many tiny holes in it. When sound waves hit the soft surface, some of the waves enter those holes. The soft surface absorbs sound waves. It makes sounds quieter.

So, you can use soft things to make sounds quieter. What are some soft things that can absorb sound waves?

_____

_____

_____

Pillows, rugs, or anything else that's made of cloth can absorb sound waves.

Suppose you play music in an empty room. The hard walls and floors will reflect the sound waves and make the music louder. Now suppose you put rugs, pillows, and curtains in the room. What happens to the music?

_____

Right. The music sounds quieter. Why?

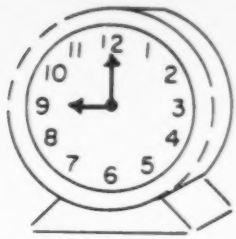
_____

The music sounds quieter because the soft things absorb sound waves.

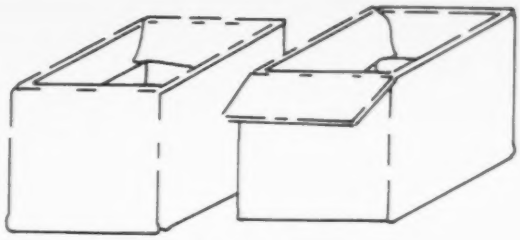
Experiment 3

What can keep a hard surface from reflecting sound waves?

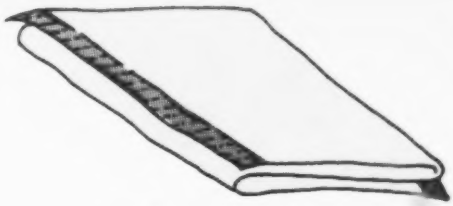
Materials



An alarm clock



2 cardboard boxes

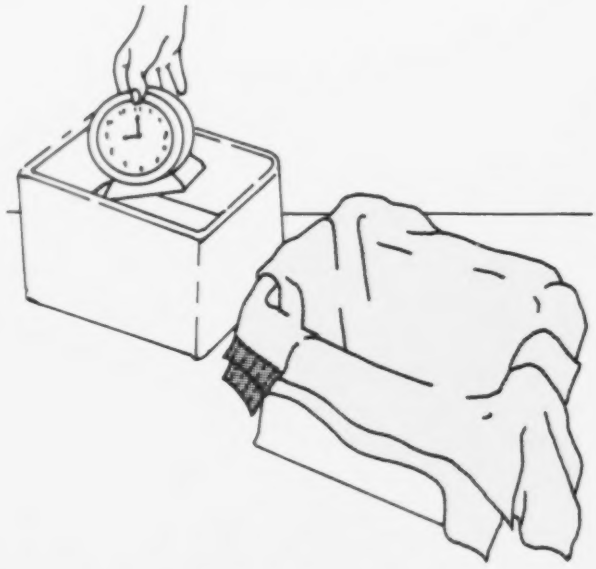


A lightweight blanket

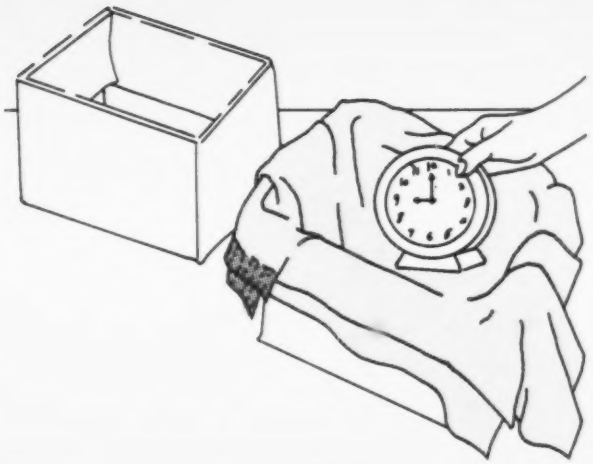
Procedure

1. Put the boxes on a table. Line one box with the blanket.

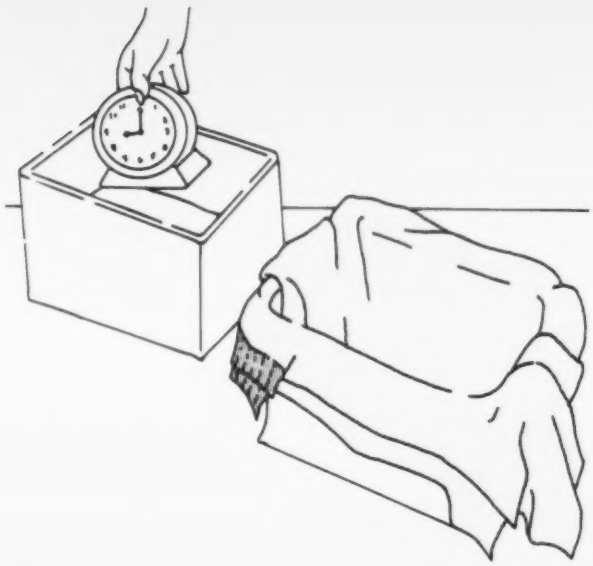
2. Get the alarm clock. Make the alarm go off. While the alarm is ringing, put the clock in the empty box. Listen to the sound.



3. Let the alarm go on ringing. Move the clock to the lined box. Listen to the sound now. Is it louder or quieter than before?



4. Move the clock from one box to the other several times. Listen and compare the sounds.



Observations

The empty box has a hard surface. The lined box has a soft surface.

1. Is the sound louder or quieter when you move the clock from the empty box to the lined box?

_____

2. Is the sound louder or quieter when you move the clock back to the empty box?

_____

Conclusion

A hard surface reflects sound waves. It makes sounds louder.

What can keep a hard surface from reflecting sound waves?

_____a. Putting something hard on the hard surface

_____b. Putting something soft on the hard surface

_____c. Putting a clock on it

Check Yourself

Show what you learned in this unit. Finish these sentences. The words you'll need are listed below.

echo	spreading	louder
absorb	reflect	quieter

1. Hard surfaces _____ sound waves and make sounds louder.
2. A sound that bounces back to your ears is called an _____.
3. If you keep sound waves from _____ a sound will be louder.
4. Soft surfaces _____ sound waves and make sounds quieter.
5. A sound is _____ when you hear it and its echo at the same time.
6. You can use soft things to make a sound _____.

Check These Out

1. Find out what a megaphone is. Make one out of newspaper or a large paper bag.
2. Some people work with machines that make loud sounds. Those people often have hearing problems. In a newspaper or a magazine, find a story about this. Tell the class what's being done about it.
3. Visit a concert hall. Find out how the different surfaces in the hall make the music sound better. Tell the class what you learned.
4. Here are more things you may want to find out:
   - What is a decibel? Why do scientists measure decibels?
   - What is a whispering gallery? How does it work?
   - What is sonar? How do bats use it?
   - When a concert hall is full of people, music sounds different than when the hall is empty. How does it sound different? Why does it sound different?

Unit 6

Using What You Know

Suppose you want to listen to music. But someone in your house wants to take a nap. If the music is too loud, it will bother the other person. But if the music is too quiet, you won't be able to hear it. Can you do anything to control the sound? You can.

- What is the science of sound control?
- How can you make a stereo sound louder, without turning up the power?
- How can you keep sound in a room?

You'll learn the answers in this unit.

Before You Start

You'll be using the science words below. Find out what they mean. Look them up in the Glossary. On the lines below, write what the words mean.

1. **acoustics** _____

_____

2. **amplify** _____

_____

3. **soundproof** _____

_____

Controlling Sound

Picture this: Your stereo is in the living room. You want it to sound louder so that you can hear it in the bedroom. What can you do?

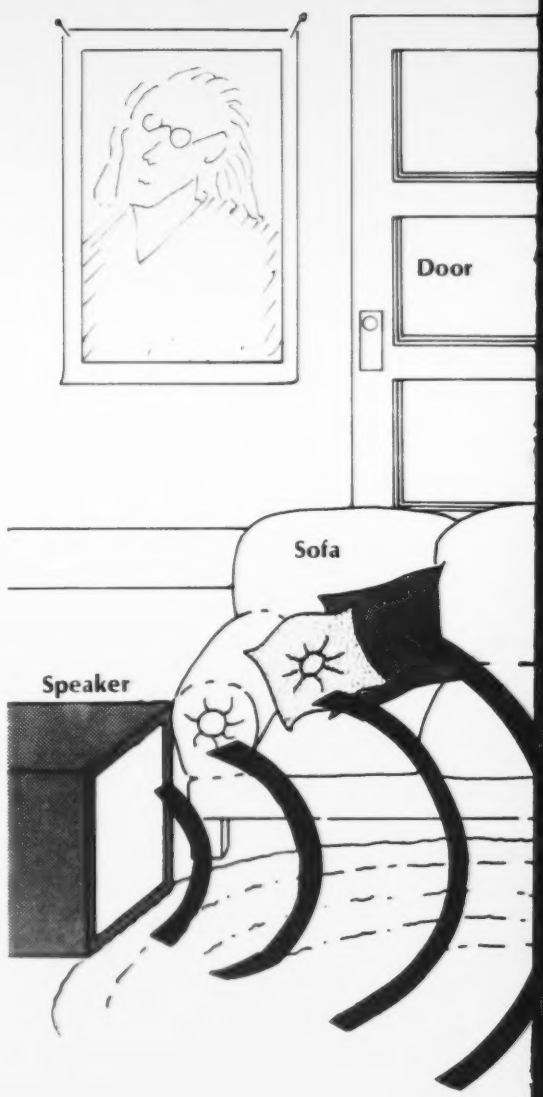
You can turn up the power. But if you turn up the power, the stereo might bother your neighbors.

So what else can you do? How can you amplify the sound of the stereo—without turning up the power? You can use what you know about acoustics. Acoustics is the science of sound control.

You've learned a lot about acoustics in this book. You know how sound travels. You know what happens when sound waves hit hard surfaces or soft surfaces.

People who build buildings use acoustics. They build some places to amplify sounds—to make sounds louder.

A concert hall amplifies sounds. What do you think a builder puts in a concert hall to amplify sounds?

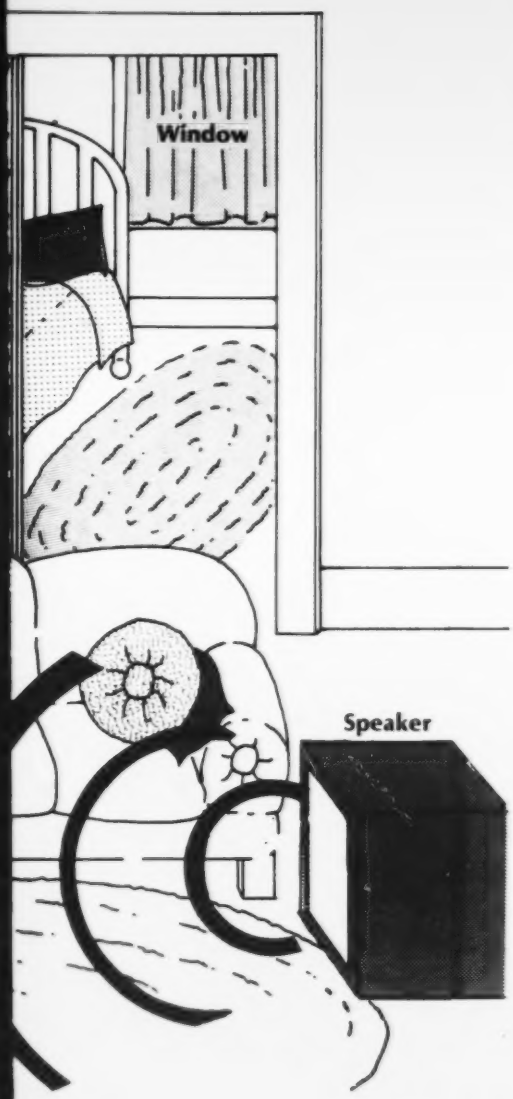


To amplify sounds, a builder puts in concrete walls, a wooden stage, and metal chairs. Those things have hard surfaces. They reflect sound waves and make sounds louder.

Builders also use acoustics to soundproof some places. They want to keep sounds from going in or out.

Most movie theaters are soundproofed. What do you think a builder puts in a movie theater to soundproof it?

A builder puts carpets on the floor, curtains on the walls, and cloth on the seats. Those things all have soft surfaces. They absorb sound waves and keep sounds from going out of the theater.



Making Sound Louder

Look at the living room and bedroom in the picture. Suppose they're part of your home. Your stereo is in the living room. You want to hear it in the bedroom, without bothering your neighbors. Use what you know about acoustics to do that.

1. Look at the speakers. Each speaker sends sound waves straight ahead. What can you do with the speakers to make the sound louder in the bedroom?

   You can turn the speakers so that they face the doorway of the bedroom. Why would that make the sound louder in the bedroom?

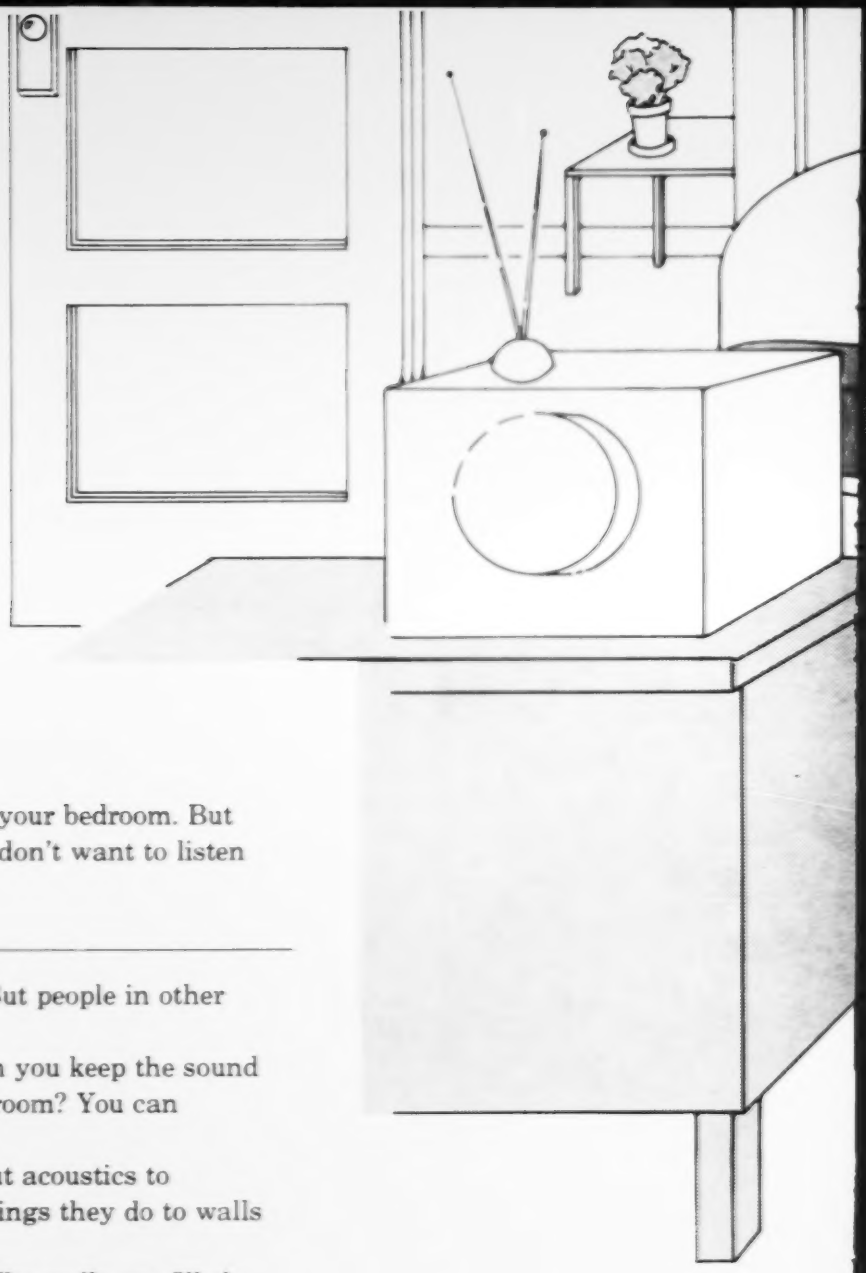
2. Notice the large sofa between the speakers and the doorway. The soft surface of the sofa absorbs sound waves. What can you do with the sofa to make the sound louder in the bedroom?

   You can move the sofa away from the speakers. Why would that make the sound louder in the bedroom?

3. Look at the window in the bedroom. It's covered with heavy curtains. What happens when sound waves hit the curtains?

   The curtains absorb sound waves. What can you do to the curtains to make the sound louder in the bedroom?

   You can open the curtains. Why would that make the sound louder in the bedroom?



Soundproofing

Let's say you like to watch TV in your bedroom. But other people who live in your house don't want to listen to the sound. What can you do?

You can close the bedroom door. But people in other rooms can still hear the sound.

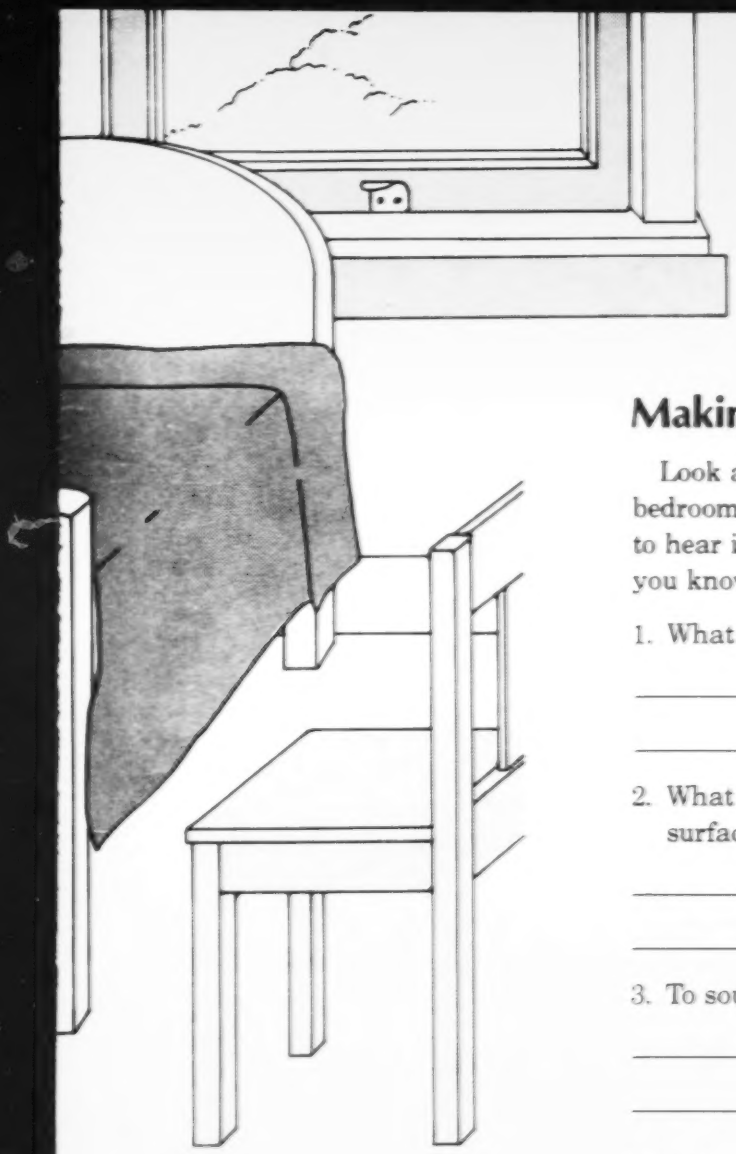
So what else can you do? How can you keep the sound of the TV from going out of the bedroom? You can soundproof your bedroom.

Builders use what they know about acoustics to soundproof rooms. Here are some things they do to walls and ceilings:

- They build thick double walls. The walls are filled with something soft that absorbs sound waves.
- They put special **acoustical tile** on walls and ceilings. The tile has many tiny holes that absorb sound waves.

Builders do other things to soundproof floors and windows. What do you think builders do to soundproof floors? (Hint: They use something soft.)

What do you think builders do to soundproof windows? (Hint: They use something soft.)



Making Sound Quieter

Look at the bedroom in the picture. Suppose it's your bedroom. Your TV is in the bedroom. You want to be able to hear it. But you don't want to bother anyone. Use what you know about acoustics to do that.

1. What hard surfaces do you see in the room?

_____ _____

_____ _____

2. What happens when sound waves hit those hard surfaces?

_____

_____

3. To soundproof the room, what changes can you make?

_____

_____

_____

_____

_____

Here are some changes you can make:

- Put a rug on the floor.
- Put curtains on the window.
- Put pillows on the chair and the bed.
- Put cloth or acoustical tile on the walls and the ceiling.
- Move the TV so that it doesn't face the door.

You've shown that you know a lot about acoustics. You know how to amplify sounds. And you know how to soundproof a room. Use what you know to control sound at home and at school.

Show What You Learned

What's the Answer?

Put an **X** in front of the right word or words.

1. What is every sound made by?
   - _____ a. A musical instrument
   - _____ b. A vibrating object
   - _____ c. A rubber band
2. What gives a sound a high pitch?
   - _____ a. Loud voices
   - _____ b. Slow vibrations
   - _____ c. Fast vibrations
3. How do sounds travel?
   - _____ a. In waves
   - _____ b. In groups
   - _____ c. In a line
4. What must a sound do for you to hear it?
   - _____ a. Bounce off a wall
   - _____ b. Travel through something
   - _____ c. Have a high pitch
5. What does a hard surface do to sound waves?
   - _____ a. Absorbs them
   - _____ b. Soundproofs them
   - _____ c. Reflects them

What's the Word?

Write the correct word for each meaning.

1. Back-and-forth motion
   V _____
2. How fast something vibrates
   F _____
3. How high or low a sound is
   P _____
4. Throw back sound waves
   R _____
5. Soak up sound waves
   A _____
6. Make louder
   A _____
7. The science of sound control
   A _____

Glossary

ab sorb: soak up something, such as sound waves

a cous ti cal tile: special building material that has many tiny holes which absorb sound waves

a cous tics: the science of sound control

am pli fy: make louder

e cho: a sound that bounces back to your ears

fre quen cy: how fast something vibrates

gas: something, such as air, that is not a solid or a liquid

li quid: something that is wet, such as water

mo tion: movement

ob ject: a thing

pitch: how high or low a sound is

re flect: throw back something, such as sound waves

sol id: something that is hard, such as metal or wood

sound proof: keep sound from going in or out of a place

sound waves: the way sound travels

sur face: the outside of something

sur round ing: all around

vi bra tion: a back-and-forth movement

Congratulations!

You've learned a lot about sound.

You've learned:

- how sounds are made;
- how sound travels;
- how to control sound; and
- many other scientific facts about sound.

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